

CLAIMS

1. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and
vertical alignment layers;
5 a liquid crystal having a negative
anisotropy of dielectric constant and inserted between
said pair of substrates;
alignment control structures arranged in
each of said pair of substrates for controlling alignment
10 of the liquid crystal; and
each of said alignment control structures
comprising a plurality of constituent units.

2. A liquid crystal display apparatus as described
in claim 1, characterized in that said alignment control
15 structure comprise linearly arranged structures.

3. A liquid crystal display apparatus as described
in claim 2, characterized in that said constituent unit
of said linearly arranged structures have substantially a
uniform shape and are divided from each other by a change
20 in shape or cutting.

4. A liquid crystal display apparatus as described
in claim 2, characterized in that the constituent units
of the linearly arranged structures of one of the
substrates and the constituent units of the linearly
25 arranged structures of the other substrate extend in
parallel to each other.

5. A liquid crystal display apparatus as described
in claim 2, characterized in that the constituent units
of the linearly arranged structures of one of the
30 substrates and the constituent units of the linearly
arranged structures of the other substrate extend in
parallel to each other and are shifted from each other.

6. A liquid crystal display apparatus as described
in claim 2, characterized in that the constituent units
35 of the linearly arranged structures of each substrate
have different lengths.

7. A liquid crystal display apparatus as described

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5 in claim 2, characterized in that the constituent units of the linearly arranged structures of each substrate are arranged in spaced relation with each other, and the constituent units of the linearly arranged structures of one substrate are located at positions between the constituent units of the linearly arranged structures of the other substrate.

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10 8. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and vertical alignment layers;
a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;
alignment control structures arranged in
15 each of said pair of substrates for controlling alignment of the liquid crystal; and
said alignment control structures of at least one of substrates having means for forming a boundary of alignment of first type in which liquid
20 crystal molecules around a point are directed to said point, and means for forming a boundary of alignment of second type in which a part of liquid crystal molecules around a point are directed to said point and the other part of the liquid crystal molecules around said point
25 are directed to a point are opposite to point.

11. 9. A liquid crystal display apparatus as described in claim 8, characterized in that said alignment control structures comprise linearly arranged structures, and each linearly arranged structure comprises a plurality of
30 constituent units, and said means for forming a boundary of said alignment of first type is arranged within said constituent unit.

12. 10. A liquid crystal display apparatus as described in claim 9, characterized in that said alignment control
35 structures comprise linearly arranged structures, and each linearly arranged structure comprises a plurality of constituent units, and said means for forming a boundary

of alignment of second type is arranged in the boundary between said constituent units.

13. A liquid crystal display apparatus as described in claim ¹²~~10~~, characterized in that in each said linearly arranged structure said means for forming a boundary of alignment of first type and said means for forming a boundary of alignment of second type are arranged alternately.

12. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and vertical alignment layers;
a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of said substrates;
alignment control structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal;
wherein the alignment control structures of one substrate are shifted from the alignment control structures of the other substrate, as viewed in the direction normal to said one substrate, and each of said one substrate and said other substrate has means for forming boundary of alignment of the liquid crystal molecules at fixed positions with respect to the alignment control structures of the opposed substrate, upon voltage application.

15 13. A liquid crystal display apparatus as described in claim ¹⁴~~12~~, characterized in that said alignment control structures comprise linearly arranged structures, and said means for forming boundary of alignment of liquid crystal molecules at constant positions are overlapped with at least a part of the linearly arranged structures opposed to said means, as viewed in the direction normal to said one substrate.

14. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and vertical alignment layers;

a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

5 alignment control structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal;

each of said alignment control structures comprising a plurality of constituent units; and

10 the constituent units of the alignment control structures of one substrate and the constituent units of the alignment control structures of the other substrate being arranged alternately on one line, as viewed in the direction normal to one substrate.

15 15. A liquid crystal display apparatus as described in claim 14, characterized in that the alignment control structures comprise linearly arranged structures, and the constituent units of the linearly arranged structures of one substrate and the constituent units of the linear wall structures of the other substrate are arranged
20 alternately with one pixel.

16. A liquid crystal display apparatus as described in claim 14, characterized in that the alignment control structures comprise linearly arranged structures, and
25 each linearly arranged structure has a plurality of constituent units in one pixel, and the linearly arranged structures are arranged substantially symmetrically in one pixel.

17. A liquid crystal display apparatus as described in claim 14, characterized in that said means for forming
30 boundary of alignment comprise partial transverse enlargement of the alignment control structures.

18. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and vertical alignment layers;
35 a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

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alignment control structures provided in each of said pair of substrates for controlling alignment of the liquid crystal;

5 each alignment control structure having a bent portion; and

an additional alignment control structure is arranged on the obtuse angle side of said bent portion of the alignment control structure of the substrate having said alignment control structures.

10 19. A liquid crystal display apparatus comprising:

a pair of substrates having electrodes and vertical alignment layers;

15 a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

alignment control structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal;

20 each alignment control structure having a bent portion; and

25 an additional alignment control structure is arranged on the acute angle side of said bent portion of the alignment control structure of the substrate opposed to the substrate having said alignment control structures.

30 20. A liquid crystal display apparatus as described in claim 18 or 19, characterized in that said alignment control structures comprise linearly arranged structures, and, in the case where said linearly arranged structures are arranged neither in parallel nor perpendicular to an edge of a pixel electrode, an additional linearly arranged structure overlapped with at least a part of the edge of the pixel electrode is arranged on the opposed electrode, in an area where said linearly arranged structure on the opposed substrate and the edge of the pixel electrode are formed at an obtuse angle.

35 21. A liquid crystal display apparatus comprising;

polarizer

a pair of substrates having electrodes and vertical alignment layers;

a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

linearly arranged structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal;

polarizers arranged respectively on the outside of said pair of substrates; and

one of said polarizers has an absorption axis displaced by a predetermined angle from an orientation rotated 45 degrees with respect to an orientation where said linearly arranged structures extend.

22. A liquid crystal display apparatus comprising:

a pair of substrates having electrodes and vertical alignment layers;

a liquid crystal having a negative anisotropy of its dielectric constant and inserted between said pair of substrates;

alignment control structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal;

at least one of said substrates having TFTs connected to the electrodes;

shielding areas arranged to cover the TFTs and the neighboring areas; and

the shielding areas and the alignment control structures being arranged in such a manner that the shielding areas are overlapped partially with a part of the alignment control structures thereby to reduce an area of the linearly arranged structures arranged in non-shielding areas.

23. A liquid crystal display apparatus as described in claim 22, characterized in that in the case where the alignment control structures of the substrate having the

TFTs is a slit, the shield areas covering the TFTs are overlapped with the alignment control structures of the other substrate.

24. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and vertical alignment layers;

a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

linearly arranged structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal;

first means arranged in the linearly arranged structures of one substrate for forming boundary of alignment of liquid crystal; and

second means arranged on the other substrate at the same position as said first means in the direction in which the linearly arranged structure extends for forming boundary of alignment of liquid crystal.

25. A liquid crystal display apparatus comprising:

a pair of substrates having electrodes and vertical alignment layers;

a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

linearly arranged structure arranged on each of said pair of substrates for controlling alignment of the liquid crystal;

the linearly arranged structures of said one substrate being formed in such a manner that the liquid crystal molecules located at least at a first position on said linearly arranged structures are aligned in the first direction parallel to said linearly arranged structures at the time of voltage application;

the alignment control structures of said other substrate being formed in such a manner that the

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liquid crystal molecules located at least at a second position on said linearly arranged structures are aligned in the second direction parallel to said linearly arranged structures and opposite to the first direction at the time of voltage application; and
5 said first position and said second position are located on a line extending perpendicular to the linearly arranged structures.

1826. A liquid crystal display apparatus as described
10 in claim 25, characterized in that the linearly arranged structures of said one substrate have means for forming boundary of alignment of first type with the liquid crystal molecules around a point are aligned toward said point, the linearly arranged structures of said other
15 substrate have means for forming boundary of alignment of first type with the liquid crystal molecules around a point aligned toward said point; and

said means of the linearly arranged structures of said one substrate for forming boundary of aligned of first type and said means of the linearly
20 arranged structures of said other substrate for forming boundary of alignment of first type are located substantially on a line extending perpendicular to the linearly arranged structures.

1927. A liquid crystal display apparatus as described
25 in claim 25, characterized in that the linearly arranged structures of said one substrate have means for forming a boundary of alignment of second type with part of the liquid crystal molecules around a point are aligned
30 toward said point and the other of said liquid crystal molecules are aligned in the opposite direction from said point;

the linearly arranged structures of said other substrate have means for forming a boundary of
35 alignment of second type with part of the liquid crystal molecules around a point aligned toward said point and the other said liquid crystal molecules aligned in the

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opposite direction from said point; and

said means of the linearly arranged structures of said one substrate for forming a boundary of alignment of second type and said means of the linearly arranged structures of said other substrate for forming boundary of alignment of second type are located on a line extending substantially perpendicular to the linearly arranged structures.

28. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and vertical alignment layers;

a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

alignment control structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal; and

auxiliary structures formed on at least one of said pair of substrates between the alignment control structures of said pair of substrates as viewed in the direction normal to said pair of substrates.

29. A liquid crystal display apparatus as described in claim 28, characterized in said alignment control structures comprise linearly arranged structures, and that said auxiliary structures are arranged at predetermined pitches along the linearly arranged structures.

30. A liquid crystal display apparatus as described in claim 28, characterized in that said auxiliary structures have a shape long in the direction perpendicular to the linearly arranged structures.

31. A liquid crystal display apparatus comprising:
a pair of substrates having electrodes and vertical alignment layers;

a liquid crystal having a negative anisotropy of dielectric constant and inserted between said pair of substrates;

alignment control structures arranged in each of said pair of substrates for controlling alignment of the liquid crystal; and

5 liquid crystal inclined alignment control means arranged between the alignment control structures of said pair of substrates in which a parameter changes in one direction from one of the alignment control structures.

10 32. A liquid crystal display apparatus as described in claim 31, characterized in that said parameter includes at least one of a height of the linearly arranged structures, a period of the linearly arranged structures, a dielectric constant of the linearly arranged structures and an accumulated value of a time
15 constant due to a resistor and a capacitor of a pixel electrode.

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